# AMERICAN WATER RESOURCES ASSOCIATION-WISCONSIN SECTION

# 30th ANNUAL MEETING

# WISCONSIN'S WATER RESOURCES: CONFLICTS AND COLLABORATIONS

**March 2 & 3, 2006**

**The Osthoff Resort**
**Elkhart Lake, Wisconsin**

**Hosts:**

**American Water Resources Association-Wisconsin Section**
**University of Wisconsin Water Resources Institute**
**Wisconsin Department of Natural Resources**
**Center for Watershed Science & Education, UW-Stevens Point**
**Wisconsin Geological and Natural History Survey**
**U.S. Geological Survey, Wisconsin District**

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**SESSION 1A:**
**Groundwater Quality Studies**
**Thursday, March 2, 2006**
**2:45 – 3:55 p.m.**

## Evaluation of Natural Attenuation at Closed Wisconsin Leaking Underground Storage Tank Sites

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Leaking underground storage tanks (LUSTs) are a major source of petroleum contamination to surficial aquifers. Approximately 20,000 LUST sites have been identified in Wisconsin since monitoring began in the 1980s, with approximately 3000 sites currently being monitored by the Wisconsin Department of Natural Resources (WDNR) and Wisconsin Department of Commerce (WDCOMM). In the past, contaminant concentrations at LUST sites were required to meet state environmental standards before closure could occur. A rule change in 1996 allowed site closure with contaminant concentrations above environmental standards under certain conditions: (1) adequate source zone control and site investigation, (2) plume shown to be stable or receding due to natural attenuation and (3) residual concentrations pose no threat to public health, safety, or the environment. Natural attenuation is defined by the EPA as the reduction of contaminant concentration and mass through physical, chemical and biological processes without human intervention. These processes include biodegradation, sorption, dilution, dispersion, volatilization, transformation, destruction, and others.

A joint WDNR/WDCOMM study is currently underway to determine whether the above conditions for site closure under natural attenuation can be adequately evaluated using current protocols. As part of this study, ground water monitoring systems were reestablished at a total of ten sites closed in 1999 and 2000 to determine changes in plume dimensions and contaminant concentrations, as well as to provide additional site characterization. These sites included four former retail gasoline stations and six other, lower-volume sites. Samples were evaluated for volatile organic compounds (VOCs) such as benzene,

ethylbenzene, toluene, and xylenes (BTEX) as well as for the gasoline additive MTBE. Seasonal variations in flow direction and water level-concentration relationships appear to be important factors in measured contaminant levels. Several parameters indicative of natural attenuation were also measured. Although these parameters suggest that natural attenuation is occurring, contamination is present at all sites. Several plumes appear to have expanded or shifted since site closure. These results indicate that, while natural attenuation is occurring at some or all sites, the five-year time interval since site closure has not been sufficient to reduce contamination levels below environmental standards, and in some cases natural attenuation is not sufficient to keep the plume from expanding.

*Note: This is a student presentation.

# Evaluation of Natural Attenuation at Closed Wisconsin Leaking Underground Storage Tank Sites

Authors: R.M. Greve, J.M. Bahr, T. Evanson, A. Pelayo, D.W. Hall, J. Skinner

WISCONSIN DEPT. OF NATURAL RESOURCES

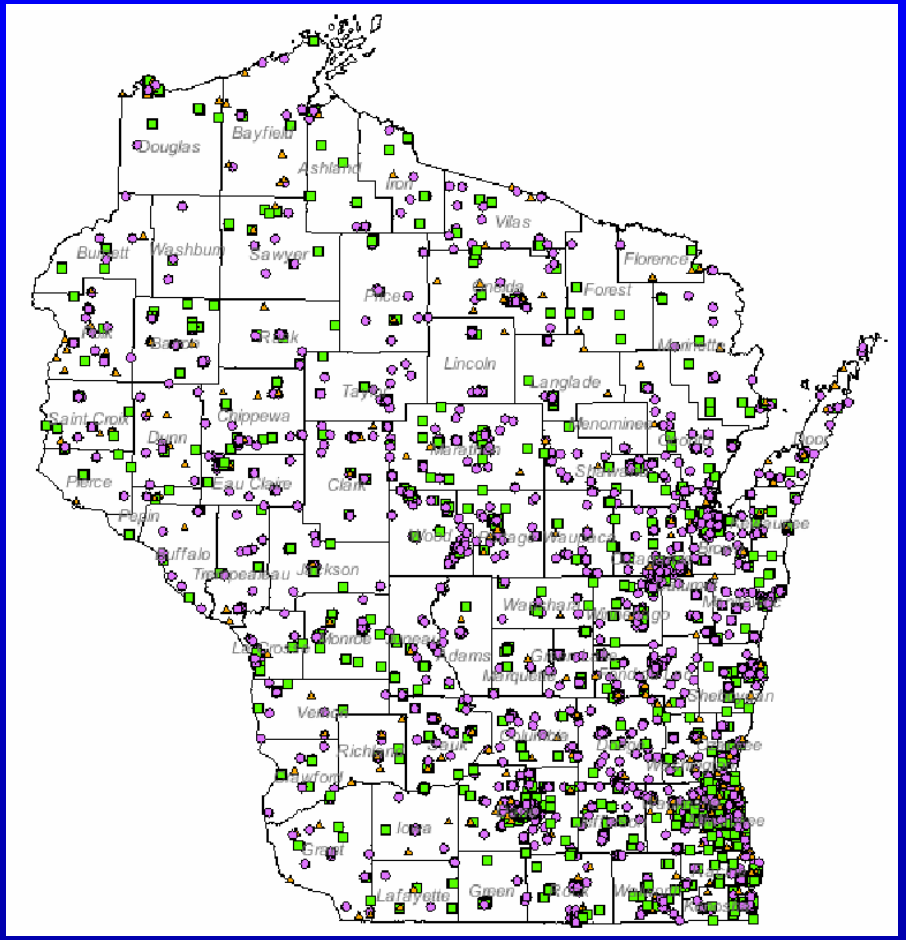
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

commerce.wi.gov Wisconsin Department of Commerce

THE UNIVERSITY of WISCONSIN MADISON

# Wisconsin LUST Sites

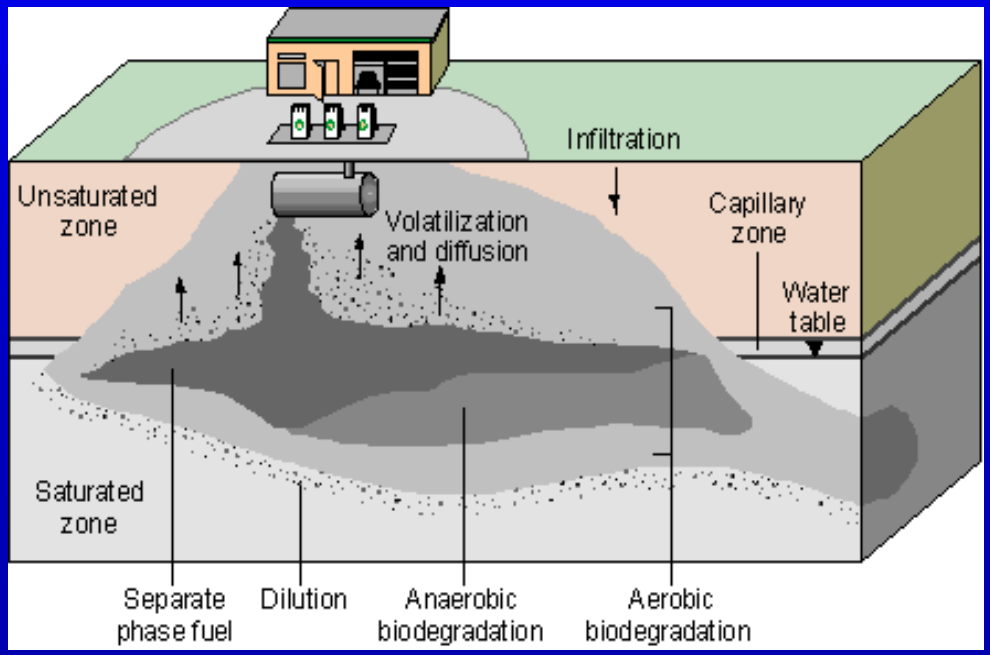
- Over **20,000** LUST sites identified since early 1980s
- **3000** sites currently monitored by DNR/DCOMM
- 1996: regulation change allows **natural attenuation** site closure
- Closure criteria
- “Reasonable period of time”



# What is Natural Attenuation?

**Processes**: **Physical**, **Chemical** & **Biological**

- **Dilution**
- **Dispersion**
- Sorption
- Volatilization
- Transformation
- Destruction
- **Biodegradation**



# Closure Protocol Study
## Field Investigation

**Goals:**

- Re-assess plume stability/migration
- Assess natural attenuation
  - Is it occurring?
  - What is a "reasonable" period of time?

**Methods:**

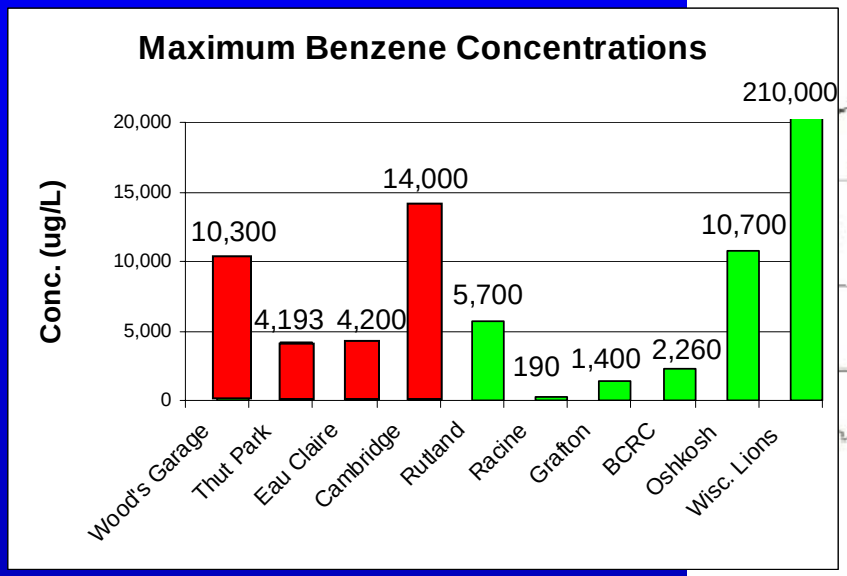
- Re-establish monitoring systems
- Expand monitoring network for further plume characterization
- Monitor chemical indicators of Natural Attenuation

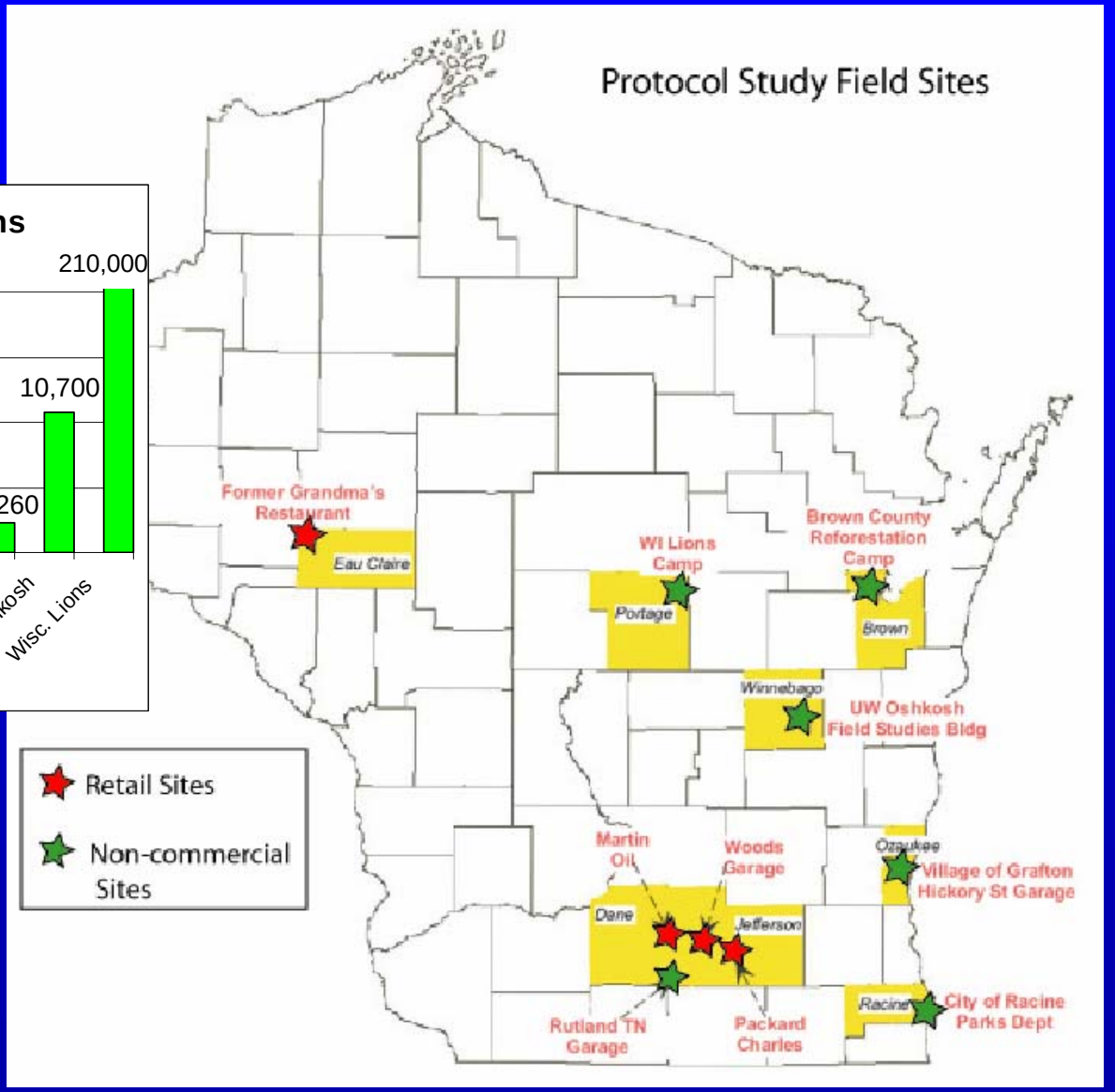
# Field Sites

## Selection Criteria – 10 Field Sites

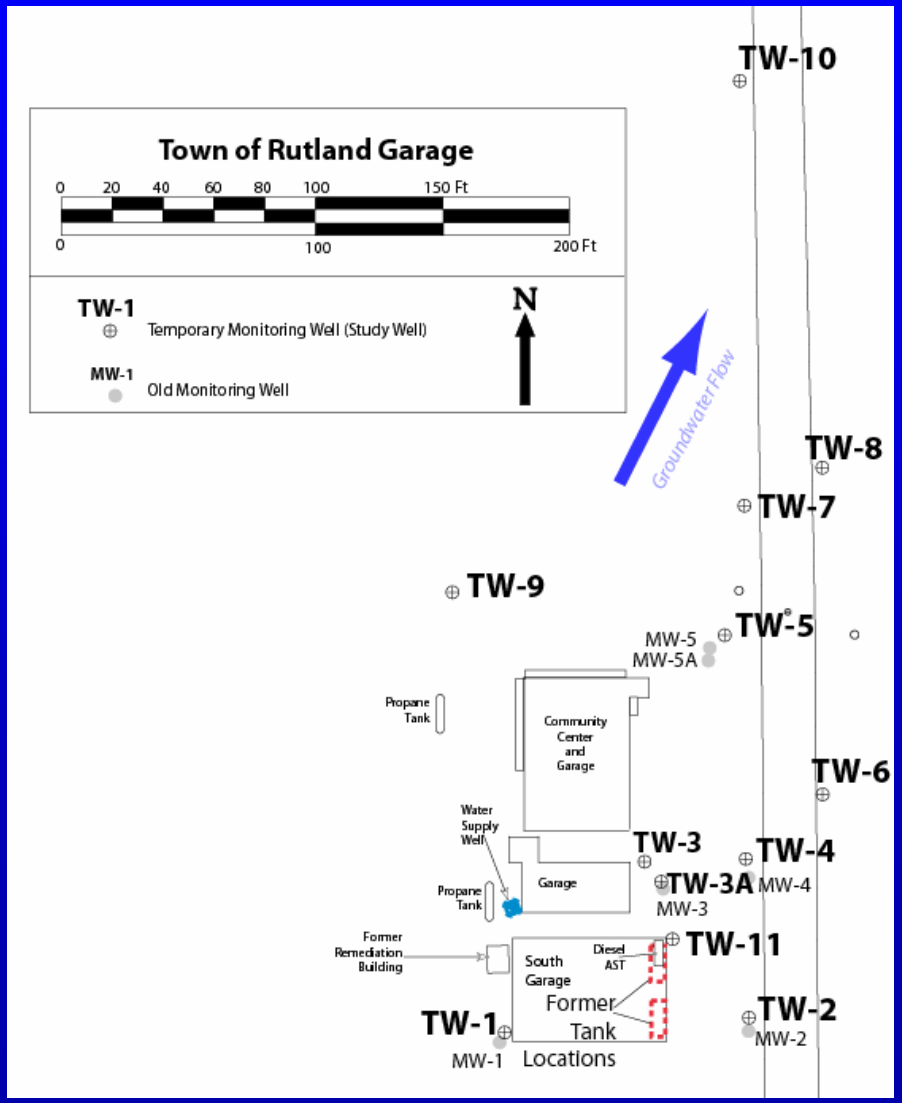
- Down-gradient wells sufficient to define historic plume dimensions
- Sufficient wells to determine historic ground water flow direction
- Representative geographic distribution around Wisconsin
- Site Access **!!**

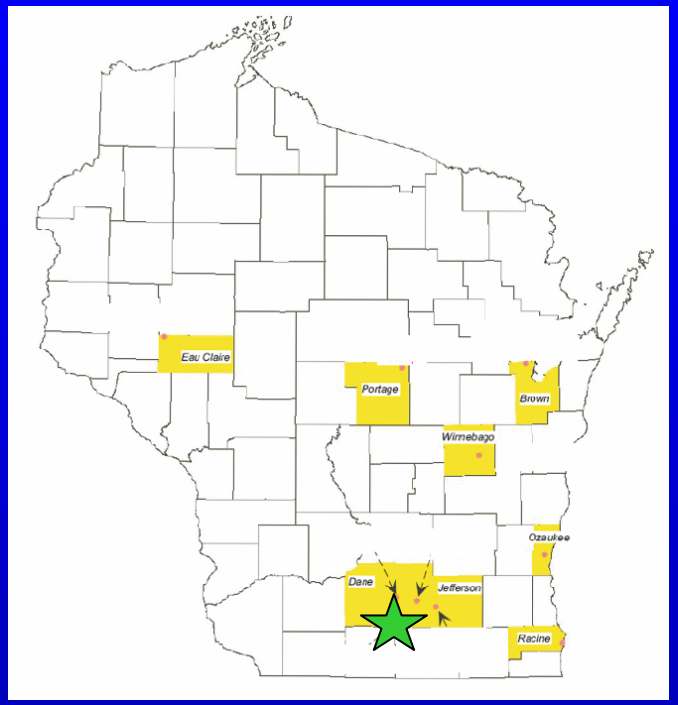
# Field Site Locations



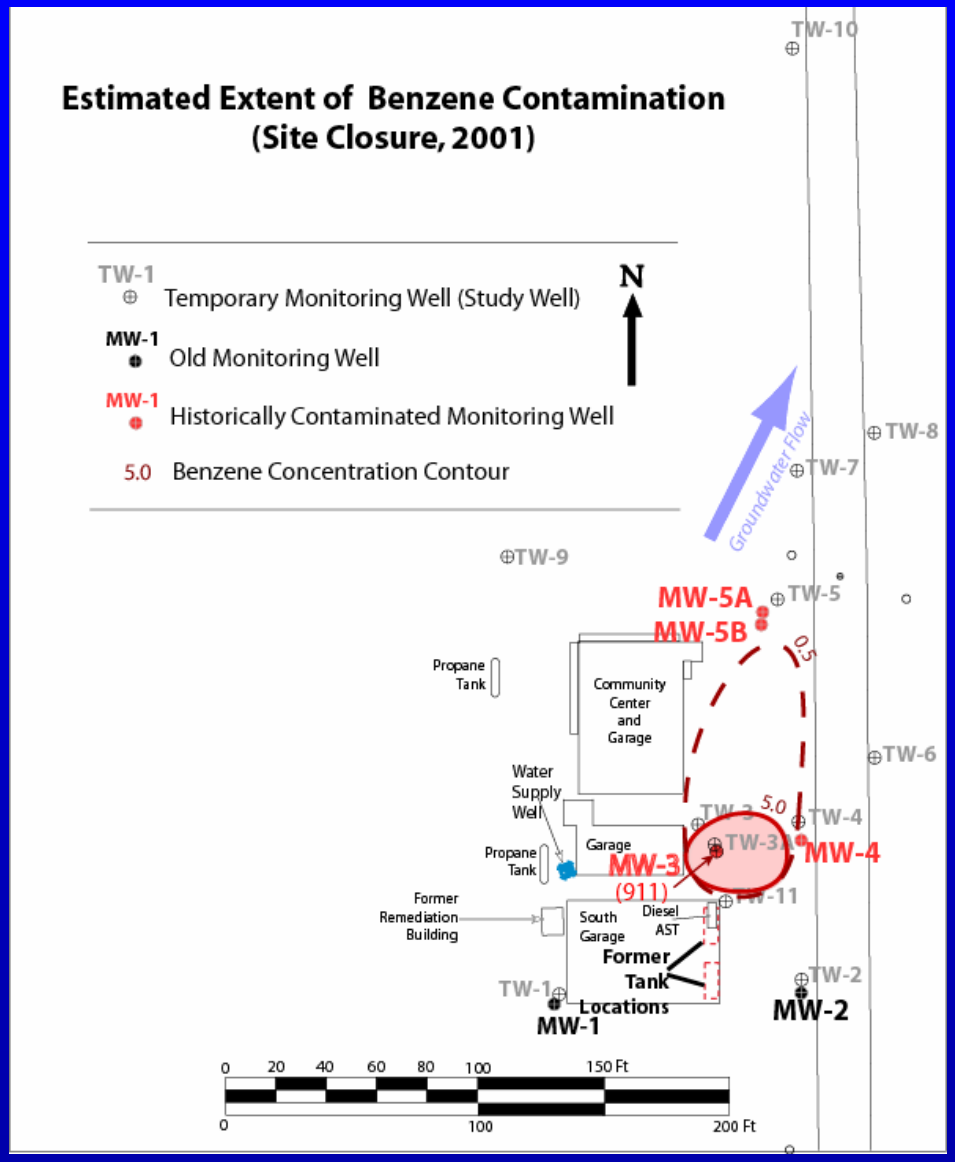
# Town of Rutland Garage




Site Location

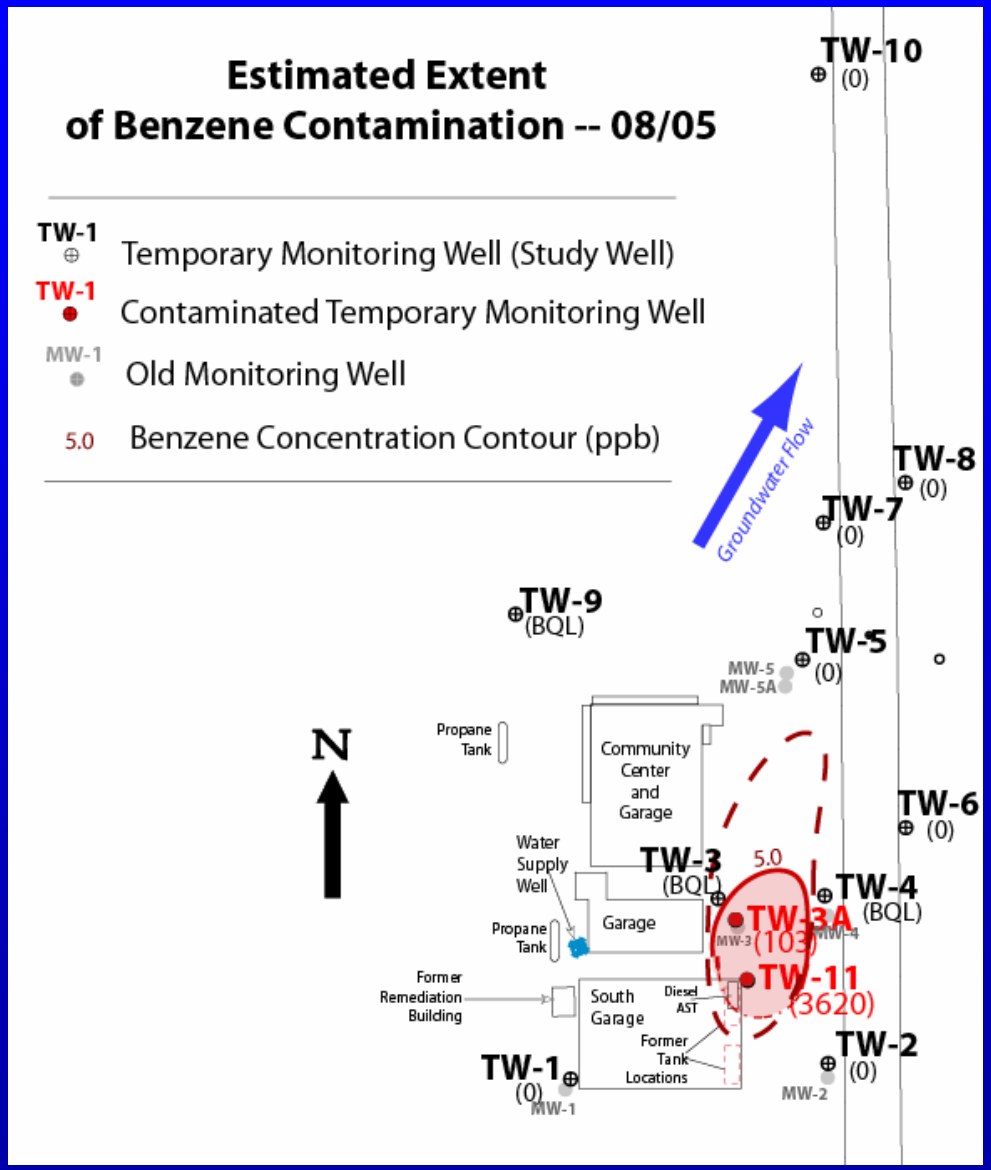
# **Rutland** - Plume Dimensions at Closure



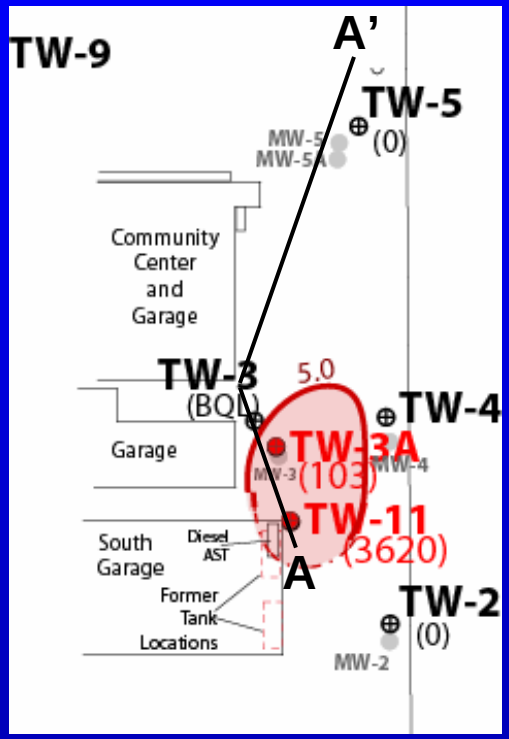

- Plume as defined before site closure
- Small area with concentrations above ES (~30’ x 40’)
- MW-4, 5A, and 5B clean at closure.

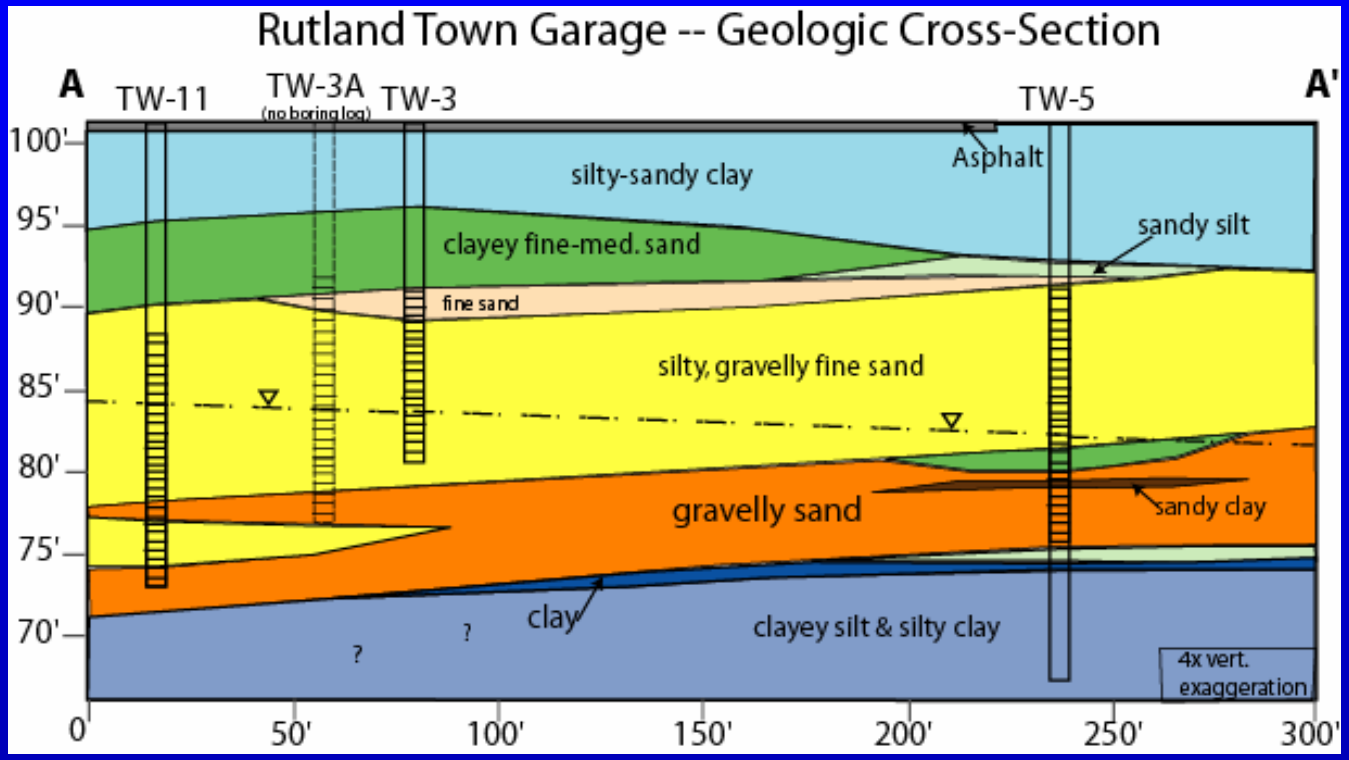
# **Rutland -** Plume Dimensions: Summer '05

- Southern extent of plume further defined (TW-11)
- NOTE: TW-3A highly contaminated. TW-3, contamination below quantification limit.



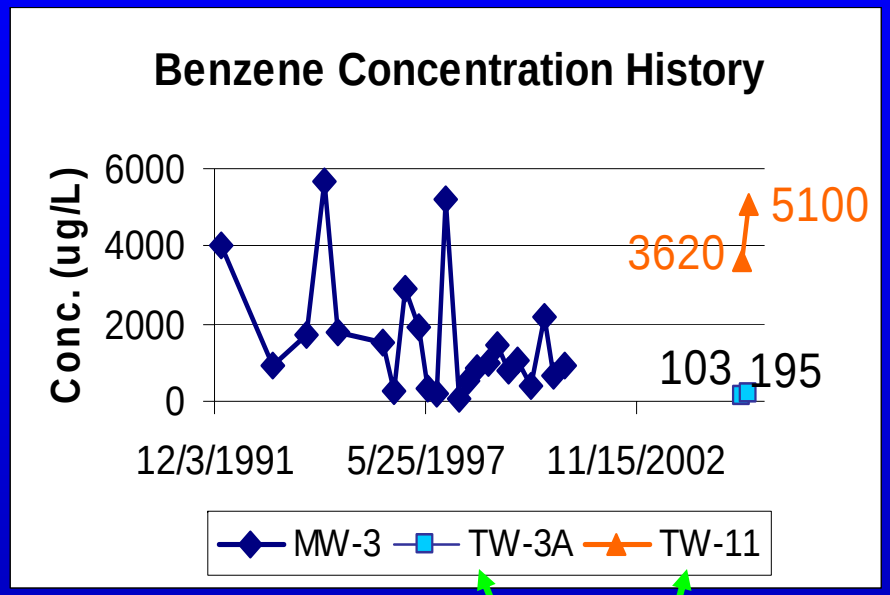
# Rutland
## Heterogeneity Effects

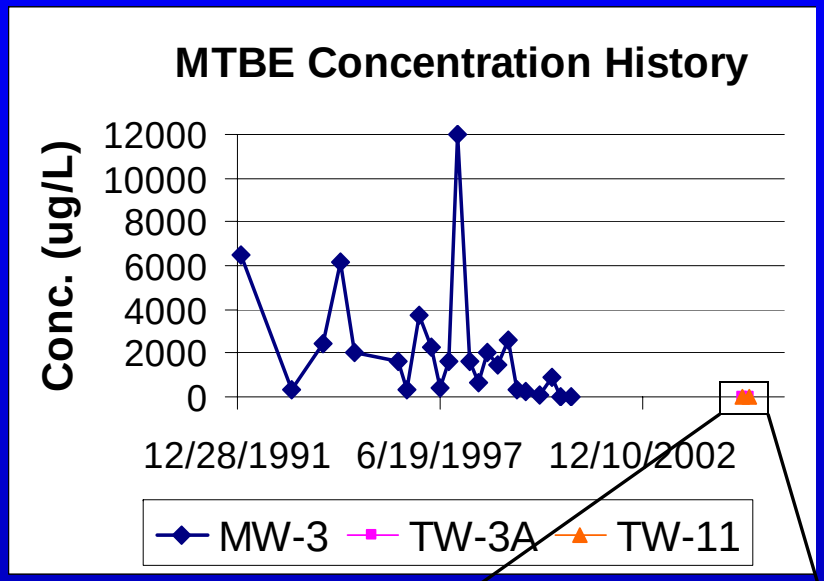


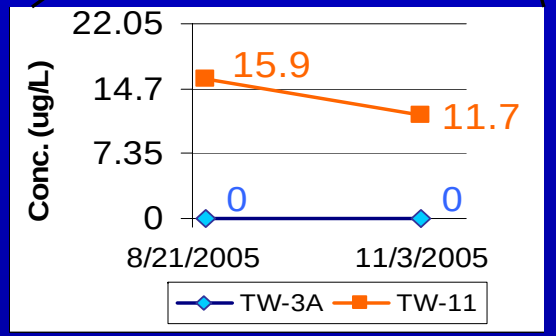

High-permeability gravelly sand forms a preferential flow path for contamination.

# Rutland
## Concentration History



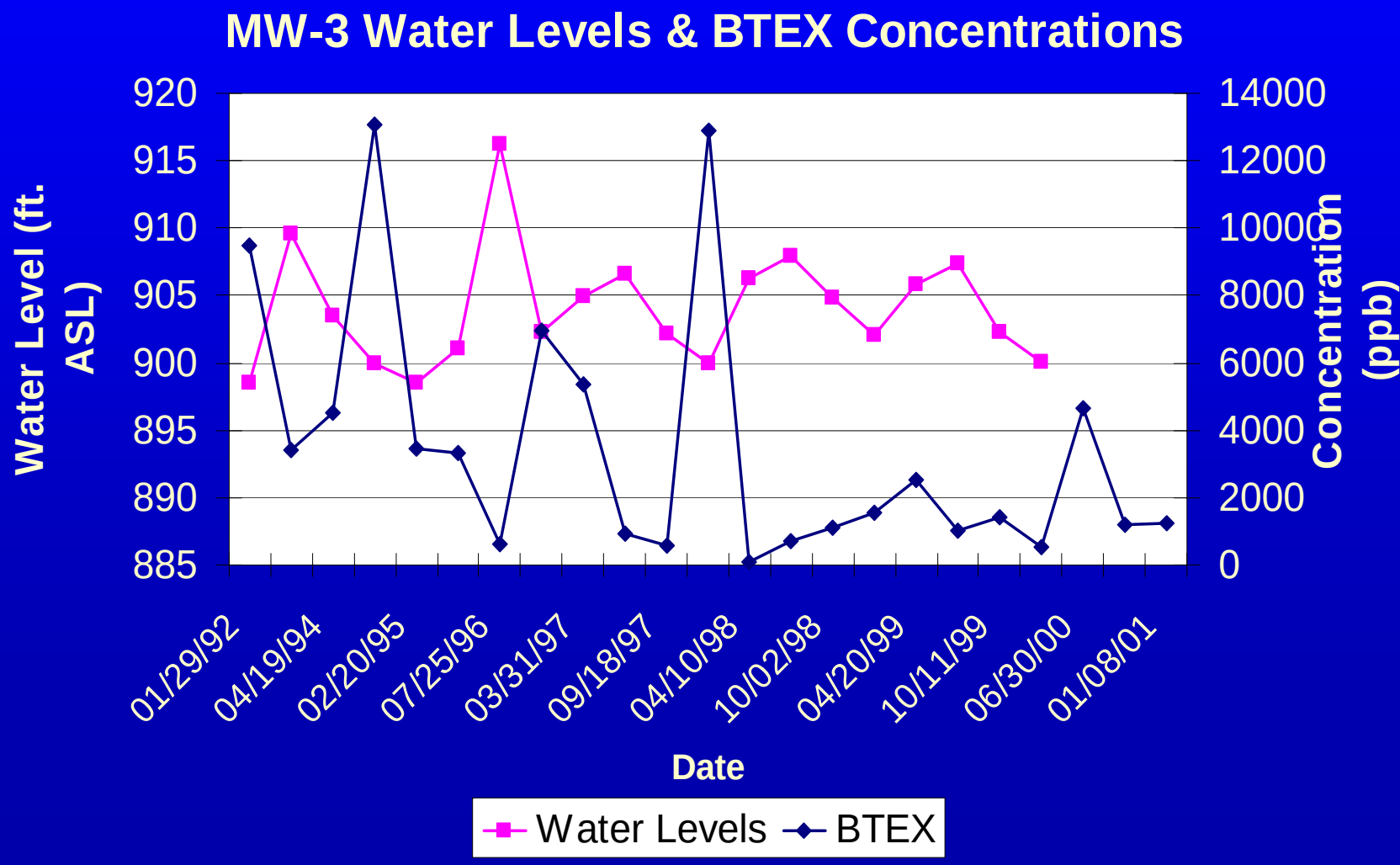




Protocol
Study Wells



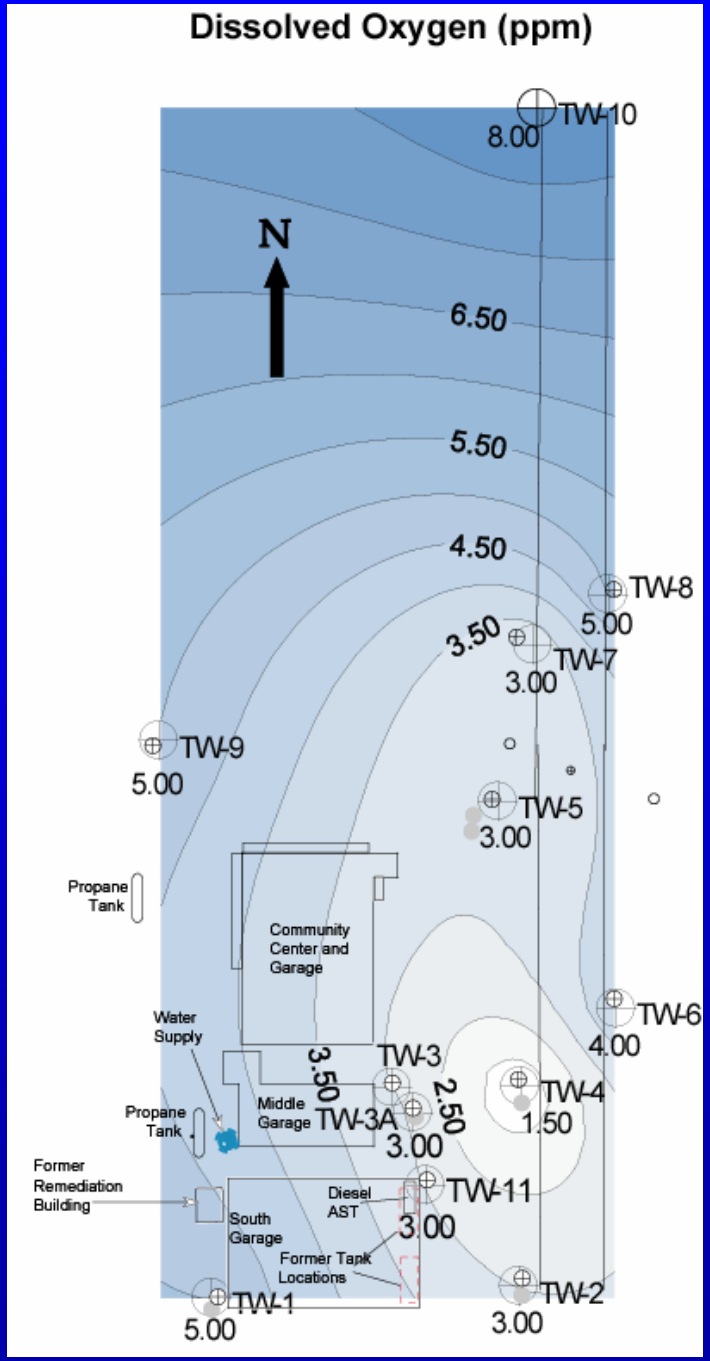
# Rutland

## Water Level-Concentration Relationship



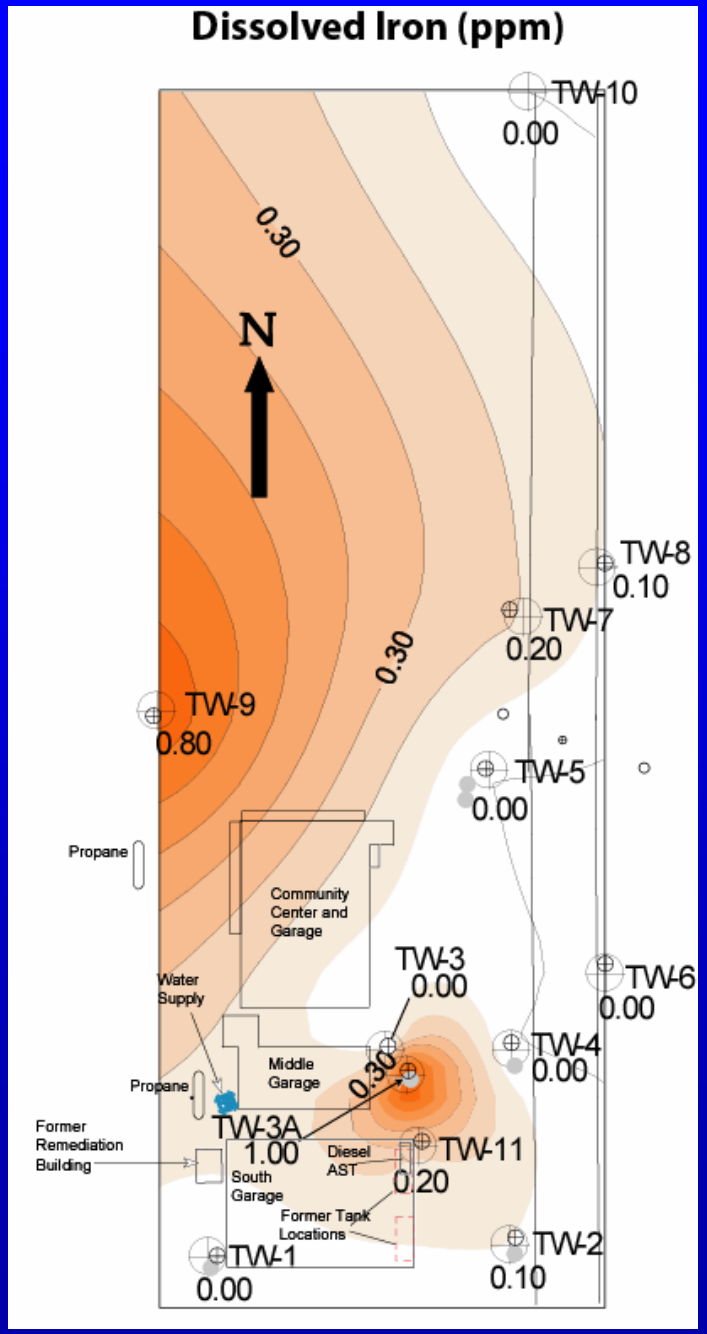
# Rutland
## Natural Attenuation

- Aerobic biodegradation occurs preferentially
- Depleted Dissolved Oxygen (DO) around source area
- Possibility that some readings biased high

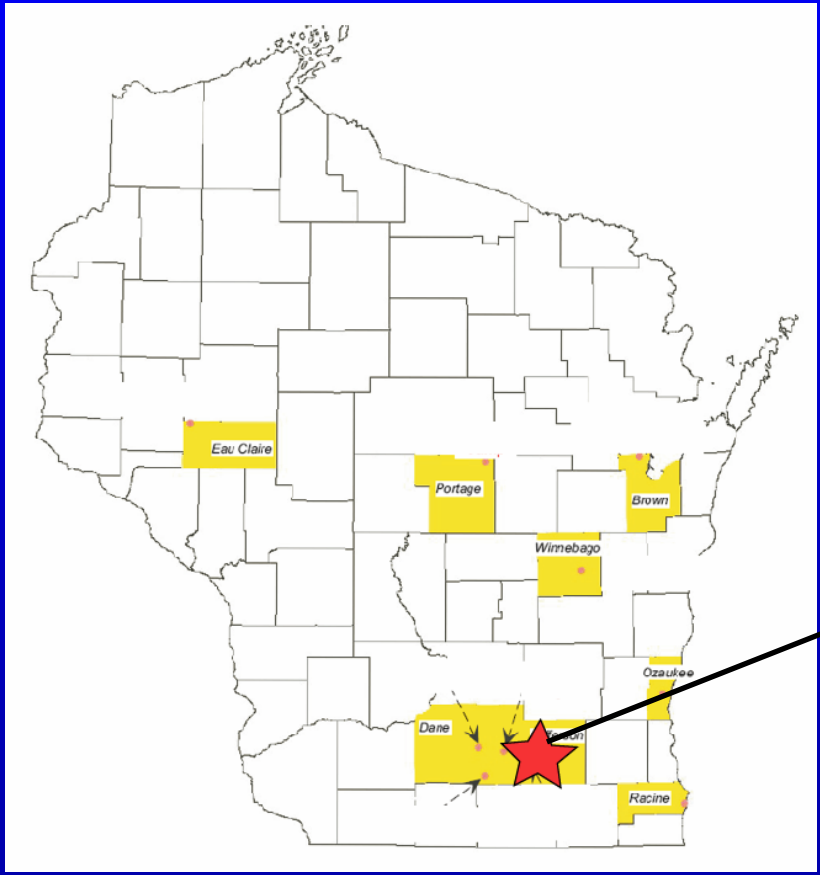


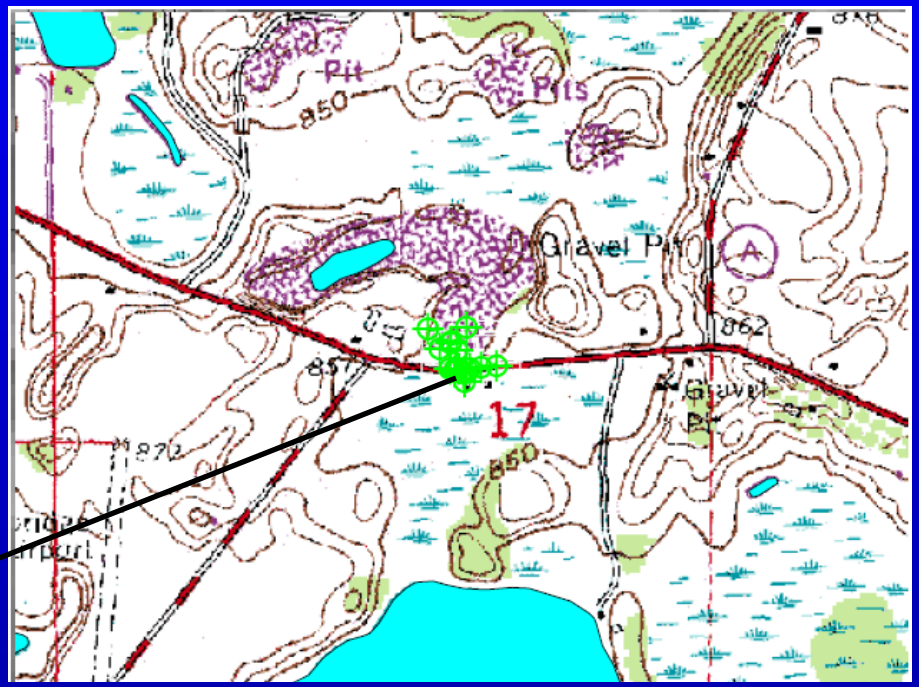
# Rutland
## Natural Attenuation

- Iron reduction also an indicator of anaerobic biodegradation
- “Bulls-eye” of high dissolved (ferrous) iron in source area

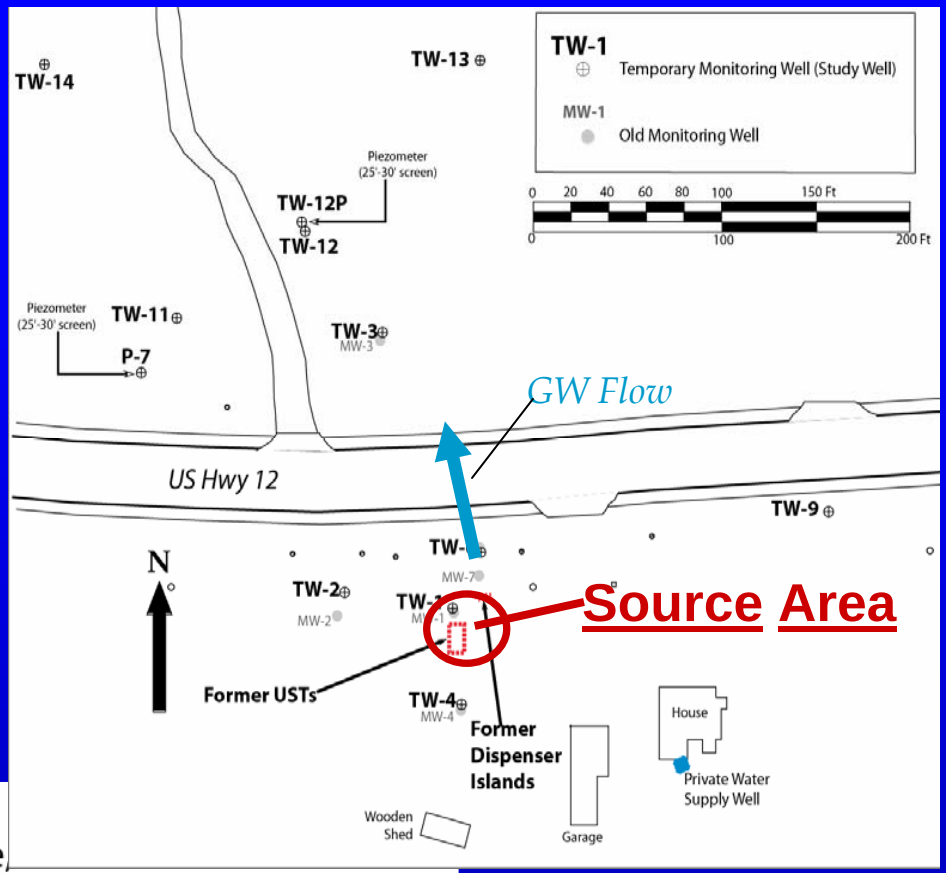


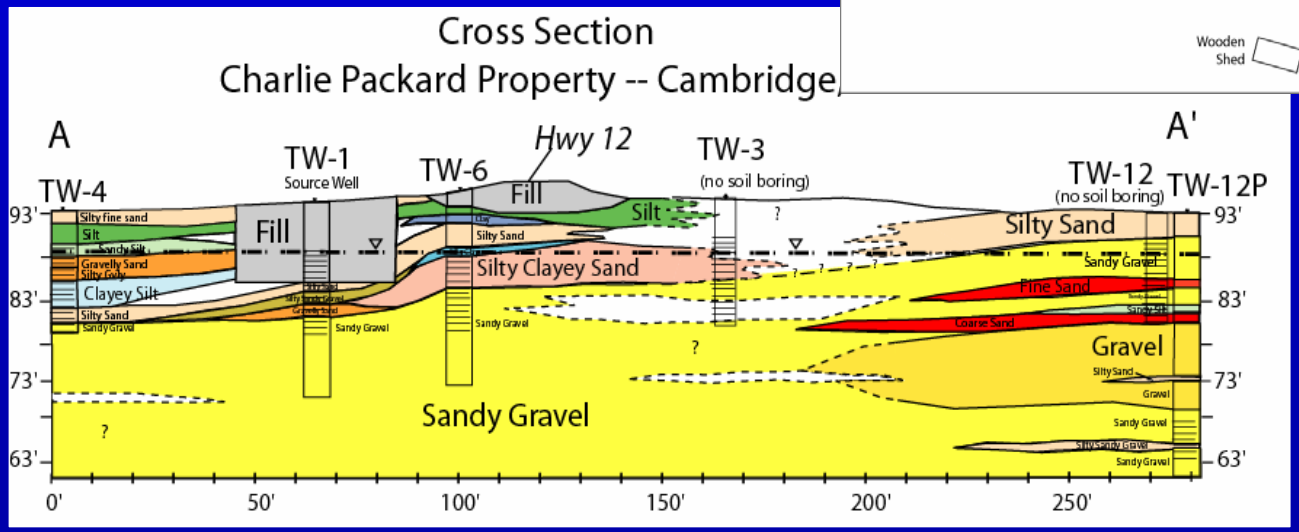
# Charles Packard Property - Cambridge



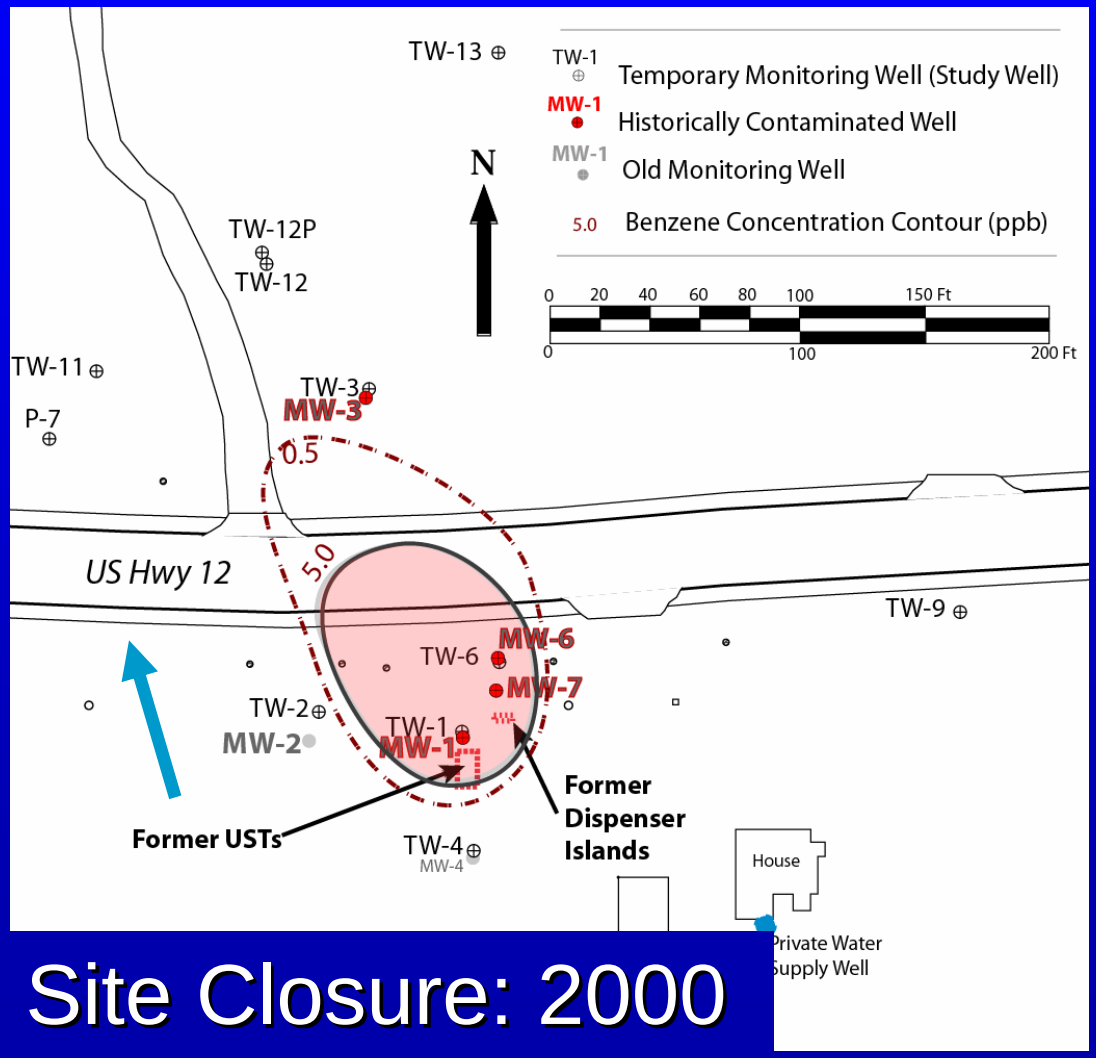



# Cambridge …Site Overview

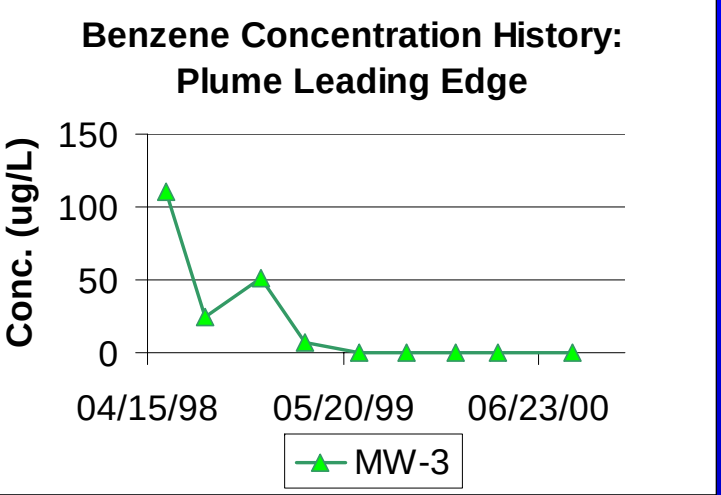


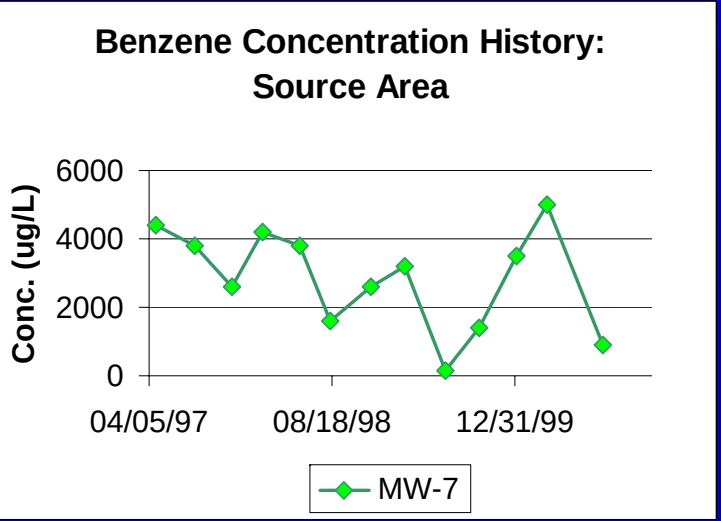



# Cambridge
# Benzene Plume Dimensions

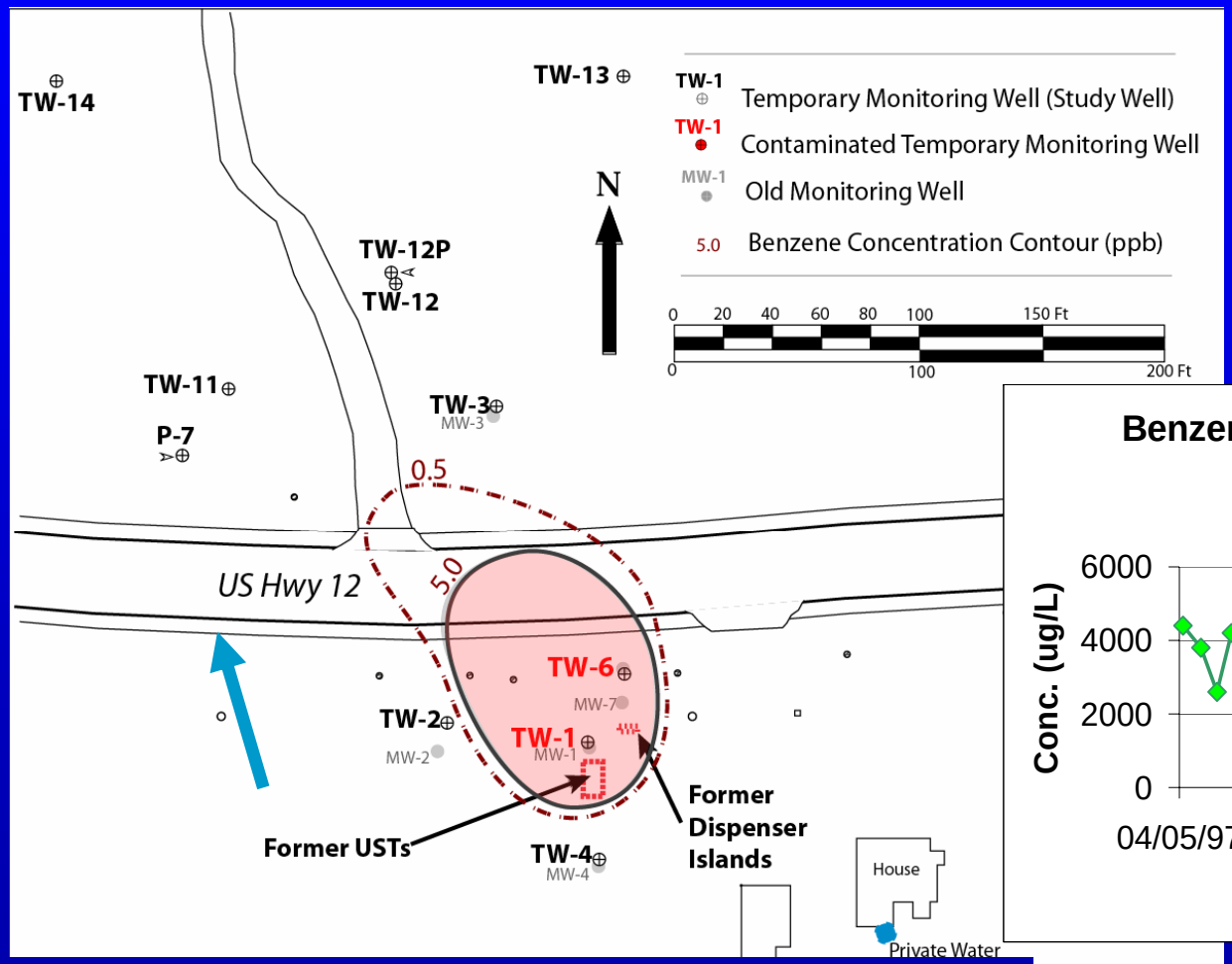


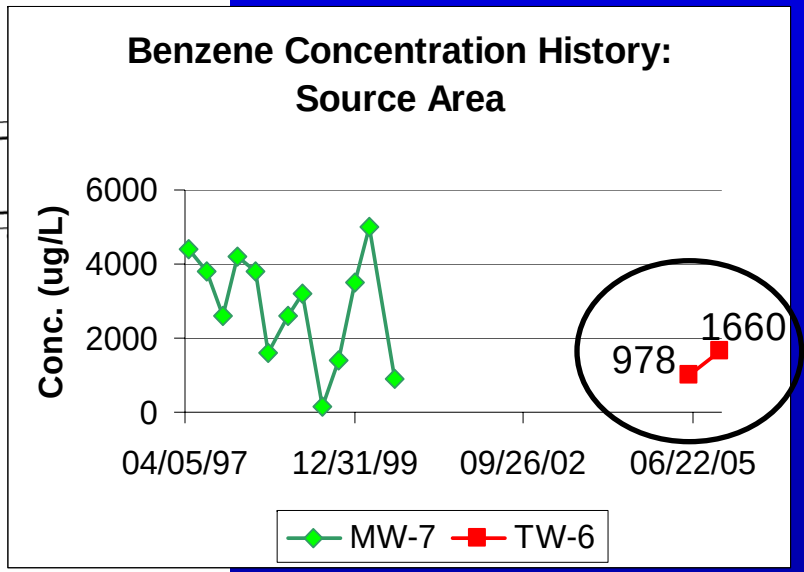

Site Closure: 2000



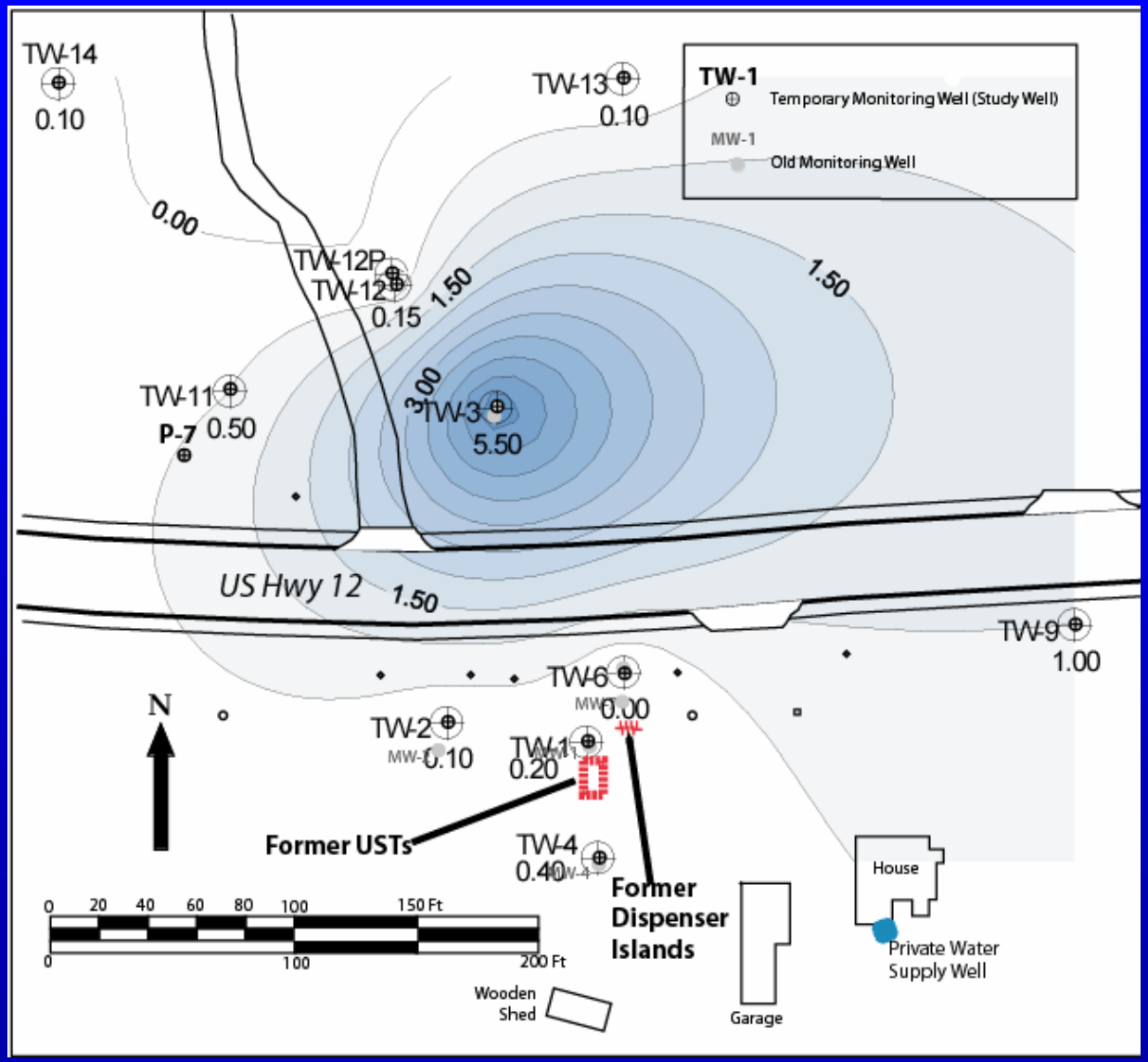
# Cambridge
# Benzene Plume Dimensions



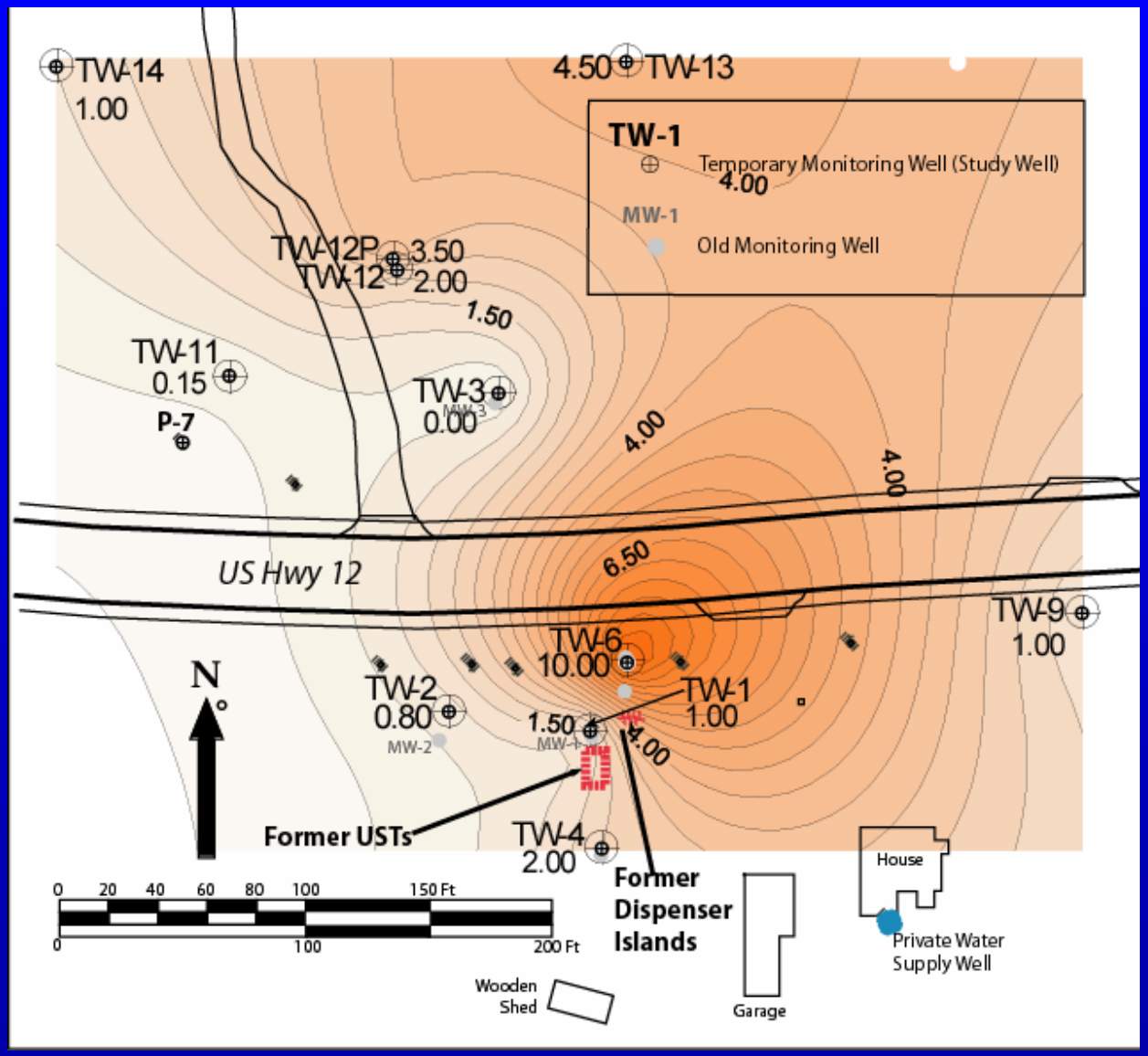

Closure Protocol Study: 2005

# Cambridge - Natural Attenuation




- Anaerobic conditions over much of site.
- Most highly contaminated well (TW-6) completely DO-depleted

# Cambridge - Natural Attenuation



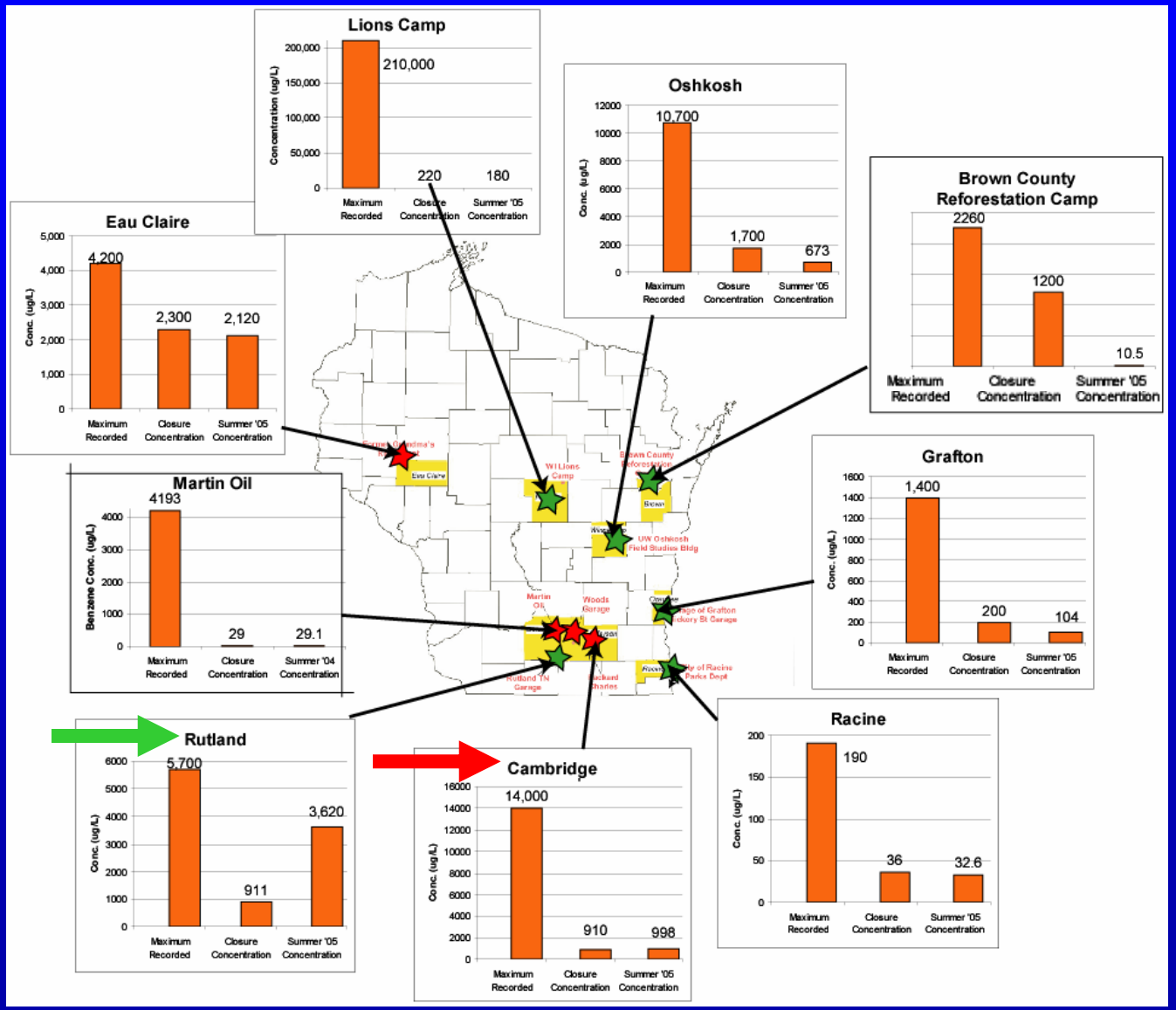

Relatively high dissolved iron at TW-6 suggests iron reduction occurring

# Field Site Summary

| | Rutland | Cambridge |
|---|---|---|
| Retail Site? | No | Yes |
| Plume Size? | 40’ x 40’ | 125’ x 75’ |
| Plume Expanding? | No | No |
| Residual Concentration? | Yes<br>6100 ppb | Yes<br>1660 ppb |
| Heterogeneity Effects? | Yes | Likely |
| Natural Attenuation? | Yes -- DO and Iron data | Yes – DO and Iron data |
| 5 years “sufficient” time? | No | No |

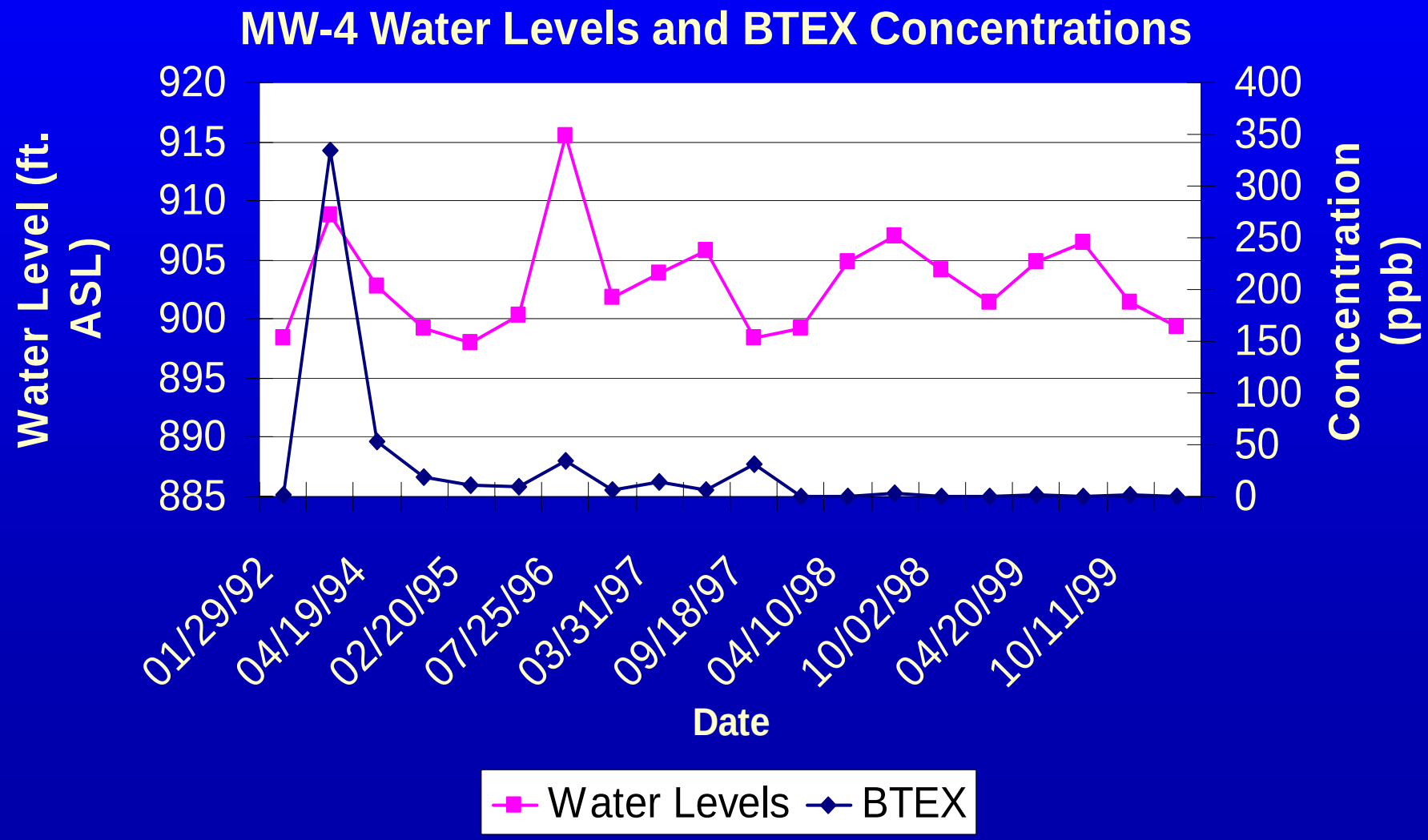
# Questions?

# All Sites - Benzene History

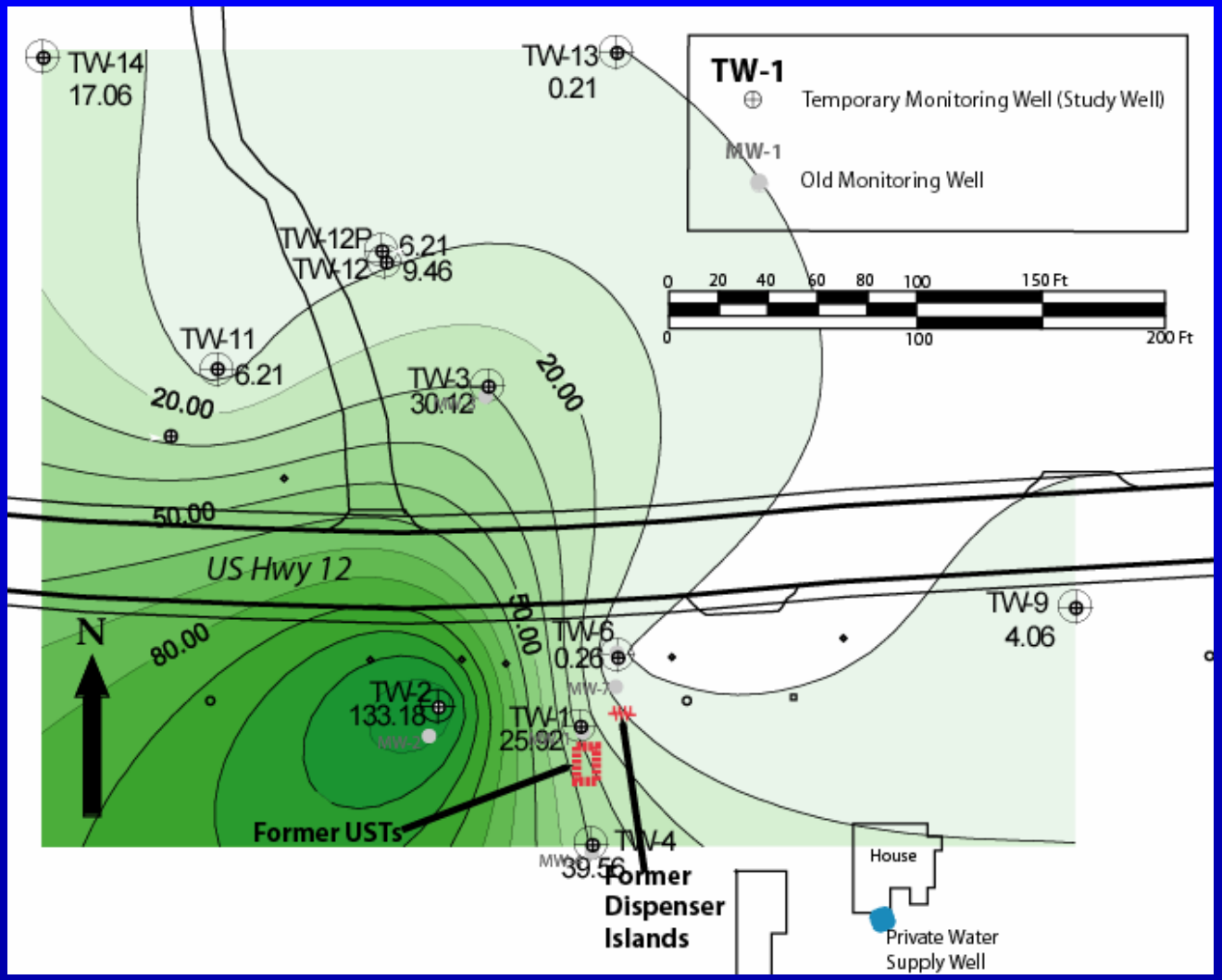


# Rutland

## Water Level-Concentration Relationship



# Cambridge - Natural Attenuation




- Sulfate distribution may reflect heterogeneities in site geology
- TW-6 depleted in sulfate relative to surrounding wells

# Rutland
## Natural Attenuation

- Sulfate reduction expected after oxygen depleted; expect low SO4 near source area
- Readings show no evidence of sulfate reduction